CHAPTER 7

Dental Caries and Periapical Pathology

DENTAL CARIES

Definition

Dental caries is defined as a progressive microbial disease of the calcified tissues of the teeth characterized by demineralization of the inorganic portion of the teeth and degeneration of the organic matrix.

For the caries to start, three factors are essential: (i) Tooth; (ii) Microflora and (iii) Carbohydrates.

The oral microflora mainly *Streptococcus mutans* and lactobacilli form a bacterial plaque or biofilm on the tooth surface. These microorganisms act on the fermentable carbohydrates giving rise to lactic acid which causes demineralization of the dental hard tissues. In the early lesions, the bacteria are present on the surface and as the lesion causes decalcification, the microorganisms penetrate into hard tissues and caries spreads deeper.

Classification of Dental Caries

Based on the surfaces affected, caries can be classified as:

i. Pit and fissure caries
ii. Smooth surface caries

Based on the tissues affected, caries can be classified as:

i. Enamel caries
ii. Dentinal caries
ii. Cemental/root surface caries

Limitations of Radiography in Diagnosing Dental Caries

i. Radiographs provide a 2D image of a 3D structure. Hence buccal caries which may be away from the pulp chamber may appear to involve the pulp on the radiograph.

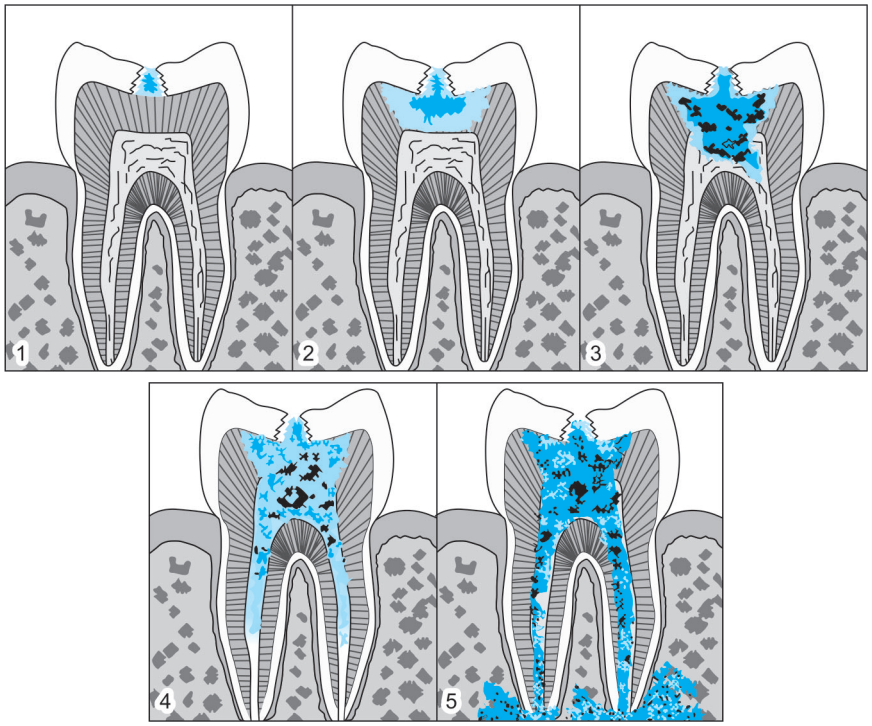

Fig. 7.1: Progression of dental caries: (1) Enamel caries; (2) Dentinal caries; (3) Caries involving the pulp; (4) Infection spreading to the root canals; (5) Periapical infection. (*Source:* Internet)

ii. At least 30% calcium salts must be removed from the tooth for the change to become apparent on the radiograph. In other words, very early incipient lesions may be missed out on the radiographs.
iii. The exact extent of caries cannot be visualized on the radiograph because a zone of demineralization at the advancing front of the lesion is not apparent. Hence it is wise not to comment about the involvement of pulp by the caries using conventional radiographic findings alone.
iv. Occlusal caries cannot be detected in their early stages.
v. Secondary caries occurring under the restorations may not be seen.
vi. As the radiograph only shows current extent of demineralization, it cannot reveal whether the lesion is active or arrested as the old inactive lesion still appears as a demineralized scar in the hard tissue. For this purpose, repeat radiographs at a later date are required along with clinical examination to ascertain the caries status.

Radiographic Appearance of Caries

1. Radiographically, caries appears as a dark shadow because calcium is removed from enamel and dentine by demineralization.
2. In the initial stages, caries cannot be seen on the radiographs because sufficient decalcification has not taken place at that time.
3. The earliest change noticed in the area of decalcification is in the form of loss of homogeneity of enamel.
4. As caries spreads, the area of decalcification increases and darker areas appear on the radiographs where the tooth has actually disintegrated. At this stage, caries appears as irregular area of radiolucency which fades into the normal dentine (Fig. 7.2).

   Bitewing radiography can efficiently detect proximal caries because (unlike IOPA) the X-rays are directed at right angles to the teeth and the centering point is at the occlusal plane.

   Recently some OPG machines have the extraoral bitewing application which may be comparable to intraoral bitewing radiography. However, the intraoral bitewing is considered superior and preferable for detection of proximal caries. In patients unable to tolerate intraoral films the extraoral bitewing will be helpful.
5. As caries reaches the dentinoenamel junction, it spreads rapidly over the surface of the underlying dentine undermining the enamel. On clinical examination such a tooth has a dark opaque hue.
6. Occlusal caries appears as a dark shadow under the enamel cap of the crown. It is seen as a triangular radiolucency with the broad

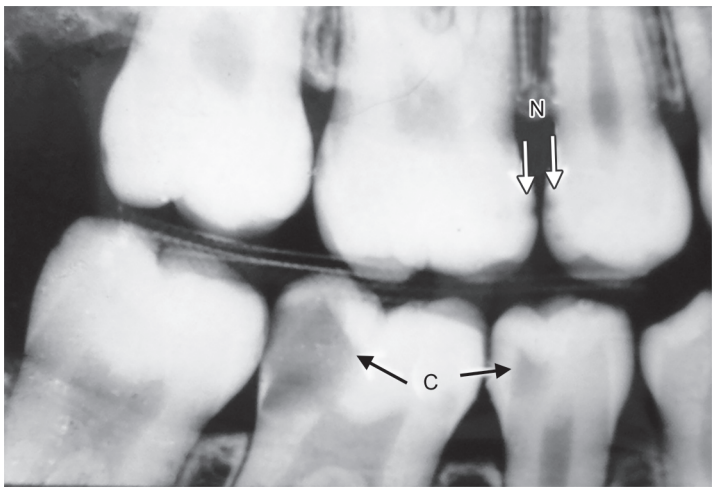

Fig. 7.2: Bitewing radiograph showing proximal caries [C]

base towards the DEJ. The classic picture of caries extending into dentine is a broad based, bowl shaped, radiolucent zone, beneath a fissure, with enamel cap unchanged. Figure 7.3 shows deep occlusal caries appearing to involve the pulp.

Proximal caries appears triangular with apex towards the pulp and base towards outside.

7. Buccal or lingual caries appear as sharply defined radiolucent areas, round or elliptical in shape (Fig. 7.4). Buccal and lingual caries cannot be differentiated from each other on a periapical radiograph. Also, they may superimpose on the DEJ giving an erroneous appearance of occlusal caries.
8. Root surface caries: More commonly seen in older patients with gingival recession. It is easily detected clinically, but X-rays will be needed for further management. Typically, it appears as a saucer-shaped radiolucency placed at CE junction, extending into root

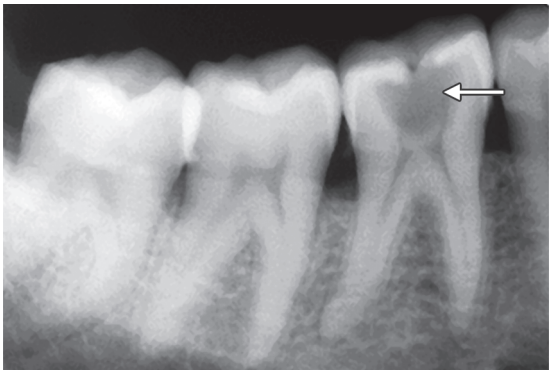

Fig. 7.3: Deep occlusal caries

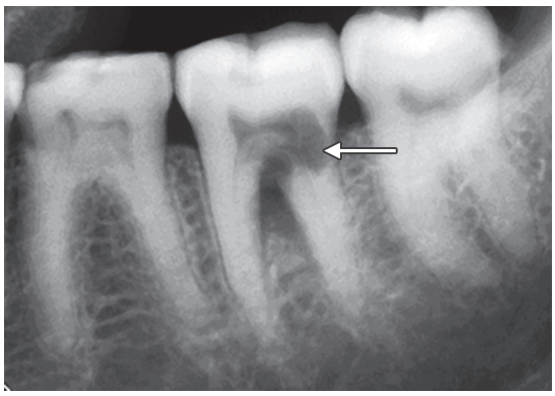

Fig. 7.4: Radiograph showing buccal/lingual caries (arrow)

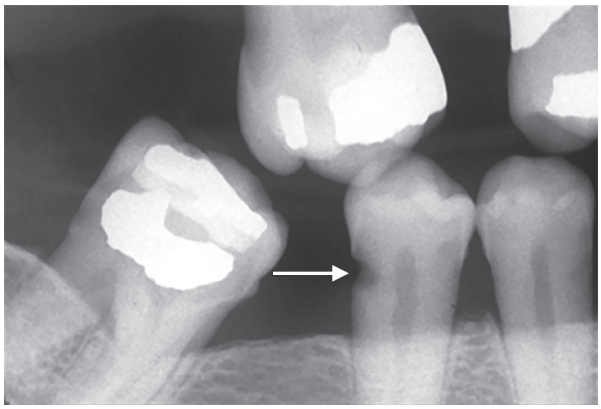

Fig. 7.5: Root caries at CE junction

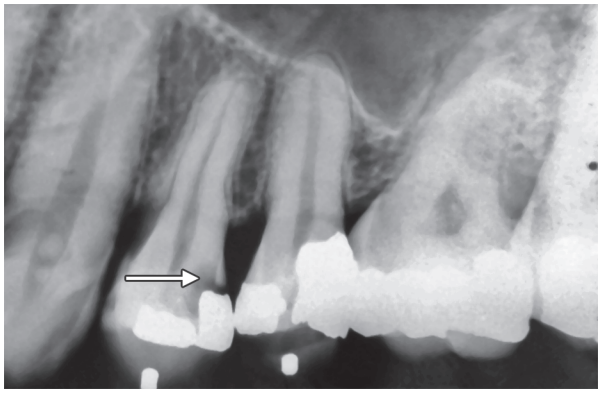

Fig. 7.6: Radiograph showing secondary caries in the first premolar

dentine and also below the enamel in the crown (Fig. 7.5). Sometimes proximal root caries may be missed on clinical examination, but detected on radiographs. Cervical burnout may be misinterpreted as root caries but it has traceable, intact root outline and no saucer shaped lucency with diffuse margin.

9. Secondary caries appears as an irregularly shaped area of radiolucency under the restoration (Fig. 7.6).

Radiographic Classification of Proximal Caries (Fig. 7.7a)

C1. Caries penetrating less than half way into the enamel surface

C2. Caries penetrating more than half way into the enamel, but not affecting the dentine

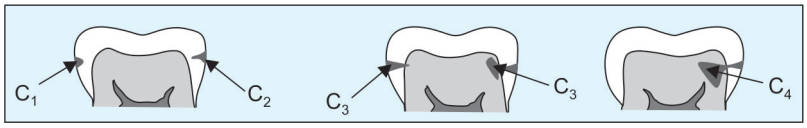

Fig. 7.7a: Proximal caries classification

C3. Caries involving the dentinoenamel junction, but less than half way to the pulp.

C4. Caries penetrating more than half way to the pulp.

Differential Diagnosis of Dental Caries (Shadows Mistaken for Caries)

1. *Erosion cavity:* It has sharp margins as compared to dental caries (Fig. 7.7b).
   Abrasion and abfraction are wasting diseases of the teeth and are caused by mechanical factors leading to superficial loss of tooth structure. Unlike caries, which results from demineralization of dental hard tissues, abrasion and abfraction are caused by mechanical wear and tear. As they are mostly seen on buccal or labial surfaces of teeth they appear as sharply defined radiolucencies with linear opaque margins (Fig. 7.7c).

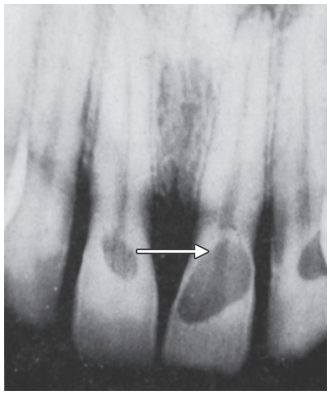

Fig. 7.7b: Erosion cavity

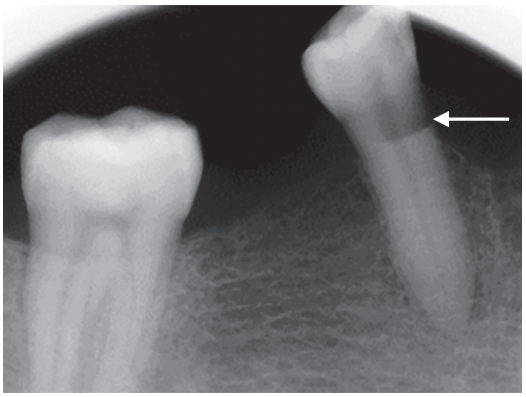

Fig. 7.7c: Abrasion defect

2. *Non-opaque fillings:* Well-defined outline form of the prepared cavity is visible on the X-ray (Fig. 7.8a).
3. *Internal resorption:* It appears as well-demarcated, punched out radiolucency which is continuous with the root canal or pulp chamber (Fig. 7.8b).

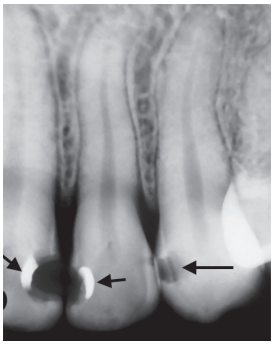

Fig. 7.8a: Opaque and non-opaque fillings with well-defined margins

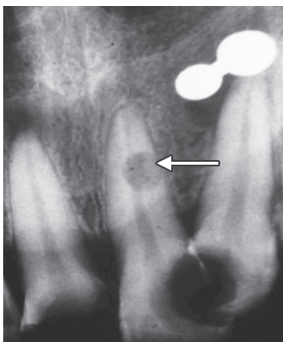

Fig. 7.8b: Internal resorption

4. ***External resorption:*** It appears in areas that are covered with bone or soft tissue and it is well demarcated (Fig. 7.9a and b).
5. ***Hypoplastic enamel:*** It is a well-demarcated radiolucency with nodules of enamel in between. The condition is usually bilaterally symmetrical (Fig. 7.10).

Fig. 7.9a: IOPA with inconspicuous lesion

Fig. 7.9b: CBCT sagittal section showing external resorption

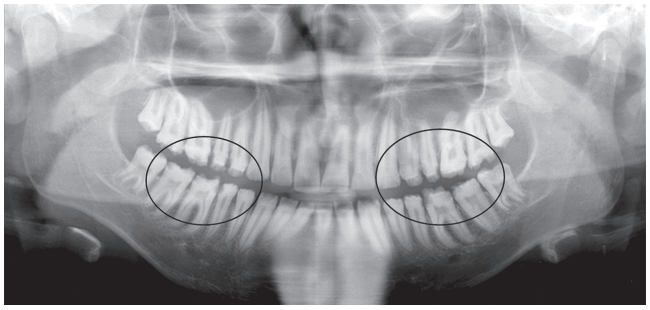

Fig. 7.10: Bilaterally symmetrical lesions of hypoplastic enamel

6. ***Radiation caries:*** Refer to radiation hazards (Fig. 7.11).
7. If the tooth is broad buccally, and narrow palatally, less radiopaque material will be available at the periphery, giving rise to a uniform, well-demarcated radiolucency resembling caries.

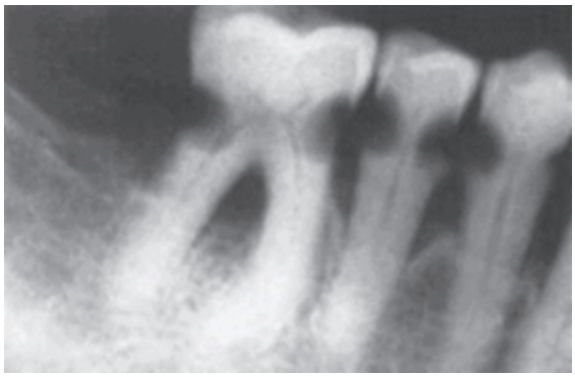

Fig. 7.11: Radiograph showing punched out appearance of radiation caries. Apple core appearance

8. ***Cervical burnout:*** Cervical burnout appears as a band-shaped radiolucency at the cementoenamel junction (Fig. 7.12). It is merely a radiographic appearance without actual demineralization of tooth structure (pseudo lesion). The coronal portion of the dentin is covered with enamel and the root portion is covered with cementum and alveolar bone. But at the cementoenamel junction, the dentine has a very thin covering of enamel (knife edge) and cementum. Hence the amount of radiopaque material available is less and a band- or wedge-shaped radiolucency appears at the cementoenamel junction which is termed cervical burnout (Table 7.1).

TABLE 7.1: Differential diagnosis between cervical burnout and proximal caries

Cervical burnout	*Caries*
It is located closer to the alveolar crest	It is located closer to the contact point
It appears as a band-shaped radiolucency	It appears as an irregular radiolucency
It appears well demarcated on the radiograph	It appears as a diffuse radiolucency on the radiograph
Cervical burnout is seen well if horizontal angulation is incorrect	Dental caries is seen well if horizontal angulation is correct
The knife edge shape of the enamel at the CEJ remains intact	The knife edge shape of the enamel at the CEJ is effaced

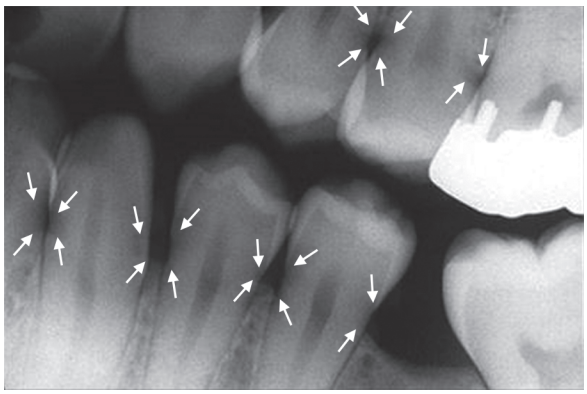

Fig. 7.12: Radiograph showing cervical burnout (arrows). (*Source:* Internet)

9. ***Mach band effect:*** At the junction of two structures, which have sharply defined density difference, the area just adjacent to the high density structure appears as low density. This is an optical illusion and is known as mach band effect. Such an optical illusion may be seen on dental radiographs at the junction of enamel and dentine, where dentine appears as an area of low density adjacent to the enamel. This may be mistaken for caries.

   The mach band effect is due to overstimulation of retinal receptors in the eye when they perceive the opaque enamel. The adjacent retinal receptors that perceive the more radiolucent dentine are inhibited. This differential response of retinal receptors results in mistaken perception of a radiolucent band at the junction of enamel and dentine. The clinician can mask the opaque enamel and study the dentine if radiolucency still persists, caries may be present. But due caution must be exercised before starting caries treatment.

PERIAPICAL LESIONS

Infection can reach the apex of the tooth either through the root canals or the periodontal ligament or through the medium of blood (anachoresis). The most common cause of periapical lesions is the sequelae of dental caries (*see* Fig. 7.1). When caries is very deep and reaches the pulp, it sets up an intense inflammatory reaction associated with throbbing pain called pulpitis. Excessive exudates and increase in vasculature gives rise to strangulation of the blood vessels at the apical foramen. This happens because the inflamed pulp is surrounded on all sides by the tooth wall and the exudate has no place to expand and exerts intense pressure on the neurovascular bundle at the apical

foramen. This strangulation gives rise to decreased blood supply to the tooth and in due course of time the tooth becomes nonvital. The infection now reaches the periapical area.

Acute Apical Abscess

During the initial stages, the inflammatory exudate is present in the bone marrow spaces and enough calcium is not removed from the trabeculae and therefore, radiograph may not show any changes. The initial radiographic finding is a widening of the periodontal ligament space which may be due to:

i. Escape of exudate into the periodontal ligament space causing slight elevation of the tooth in the socket.
ii. Resorption of root.
iii. Resorption of the apical bone.

Early indication of periapical lesion is thinning or slight decalcification (loss of opaque appearance) of apical lamina dura.

Periapical lesions appearing as radiolucencies are (Fig. 7.13)

a. Abscess
b. Granuloma
c. Radicular cyst
d. Periapical osseous (cemental) dysplasia (first stage)
e. Periapical lesion at the apex of a treated tooth
f. Apical scar
g. Apicectomy wound
h. Secondary infection
i. Residual infection at the site of an extracted tooth

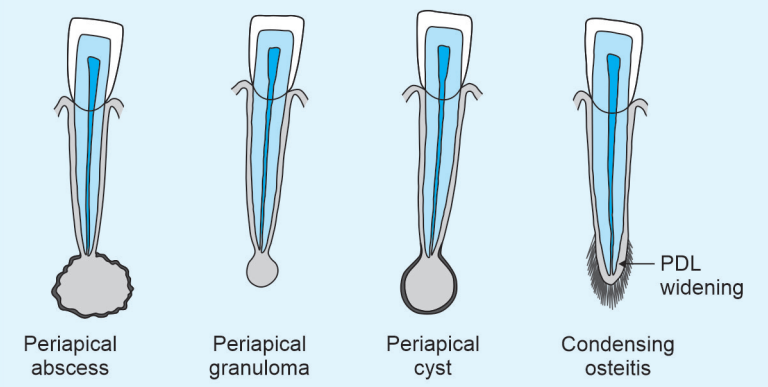

Fig. 7.13: Various periapical lesions

Periapical lesions appearing as radiopacities:

a. Condensing osteitis

b. Periapical osseous (cemental) dysplasia (mature stage).

Periapical Abscess

When the virulence of the organism is more or if the host resistance is lowered, the organisms multiply rapidly and give rise to suppuration in the apical area. In the acute stage, sufficient calcium is not removed from the periapical region and hence radiographs show no change. (Patient presenting with severe pain and obvious swelling may have no periapical lesion on the radiograph.) As this acute lesion becomes more chronic, it appears on the radiograph as a diffuse radiolucency with irregular margins, which gradually merges with the surrounding bone (Fig. 7.14). The lamina dura of the offending tooth is discontinuous in the periapical area.

Periapical Granuloma

When the resistance of the host is good or if the virulence of the organisms is low, there is an effort on the part of the body to wall off the infection thereby giving rise to a granuloma. This is usually smaller in size than a cyst and unlike a cyst appears as a well-circumscribed radiolucency without any corticated margins (Fig. 7.15). The lamina dura of the associated tooth is missing around the apex.

Periapical Cyst

The periapical cyst develops in a granuloma from the epithelial cell rests of Malassez. The development of a cyst takes place in three stages initiation, cyst formation and enlargement of the cyst. As the epithelial cells in the granuloma proliferate, the central cells degenerate to form a cystic cavity that expands by progressive accumulation of fluids.

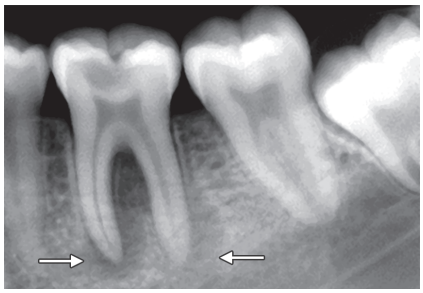

Fig. 7.14: Radiograph showing periapical abscess in both the roots of the first molar

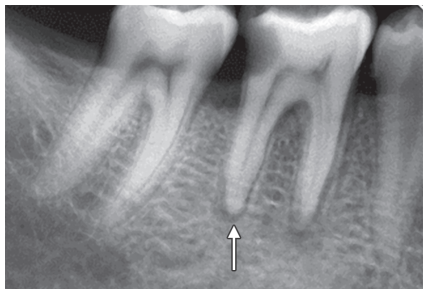

Fig. 7.15: Radiograph showing periapical granuloma distal root of the first molar

The cyst appears on the radiograph (Figs 7.16a and 7.17) as a round- or oval-shaped radiolucency surrounded by a thin white line called a corticated or hyperostotic border. This cortex is nothing but the condensation of bone due to the pressure exerted by the fluid filled lesion. The cyst may cause expansion of the cortex and might exhibit eggshell crackling as a result of excessive thinning of the bone. The cyst undergoes expansion by subperiosteal deposition of bone. Sometimes the cyst grows faster than bone formation giving rise to an area where subperiosteal bone is missing. It is at this site that eggshell crackling can be elicited. Sometimes the cyst may escape out onto the soft tissues and will show fluctuation. The radiograph then shows a window-like appearance within the cystic lumen (cyst in cyst appearance) (Fig. 7.16b).

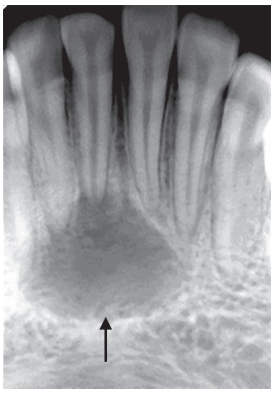

Fig. 7.16a: A radicular cyst involving central incisor, note open apex and wide root canal

Fig. 7.16b: Window formation in the cyst

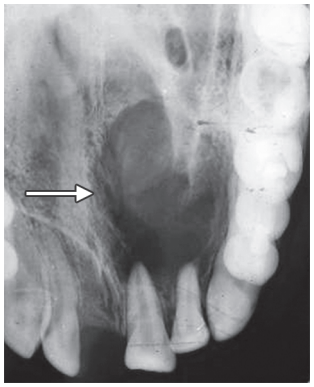

Fig. 7.17: Radiograph showing a radicular cyst

Sometimes a cystic lesion may be large and appears to involve more than one tooth. In such cases, the offending tooth can be identified as it shows wider root canal and open apical foramen because the tooth being nonvital, odontoblasts are dead and dentine is not deposited on the pulpal wall (Fig. 7.15). Whereas in normal teeth continuous deposition of dentine throughout life makes the canal and apex progressively narrower.

If a periapical cyst/lesion develops close to the floor of the sinus, it elevates the floor making it convex upwards. However, a bony wall separating the cyst and sinus is almost always present. This happens because the osteoblastic layer of the periosteum lays down new laminated type of periosteal bone. Inflammatory periosteal reaction produces a thin layer of new bone adjacent to the floor of antrum. This is described as 'Halo Shadow' because the involved root apex is surrounded by a radiolucent halo which in turn is surrounded by the thin layer of new periosteal bone (Fig. 7.18). Proliferation of the cells of the mucosal lining may present as a radiopaque band of soft tissue called mucositis (Fig. 7.19).

Condensing Osteitis

In a low grade infection, or when the resistance of the host is good, more and more bone deposition takes place in the existing marrow spaces. This gives rise to a uniform radiopaque shadow devoid of any marrow spaces. Since this condition shows condensation of bone around the root apex, it is called condensing osteitis or sclerosing osteitis (Fig. 7.20).

In this condition, root apex may show slight resorption and the lamina dura is discontinuous. Condensing or sclerosing osteitis is normally seen as a diffuse opacity which gradually merges with the

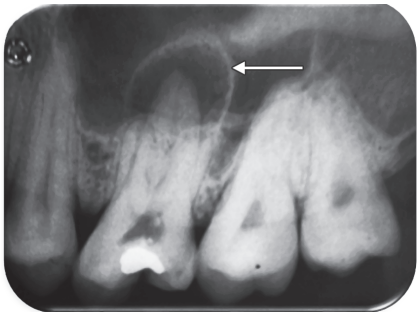

Fig. 7.18: Halo effect of periapical lesion in the antrum

Fig. 7.19: Antral mucositis adjacent to periapical lesion

Fig. 7.20: Condensing osteitis

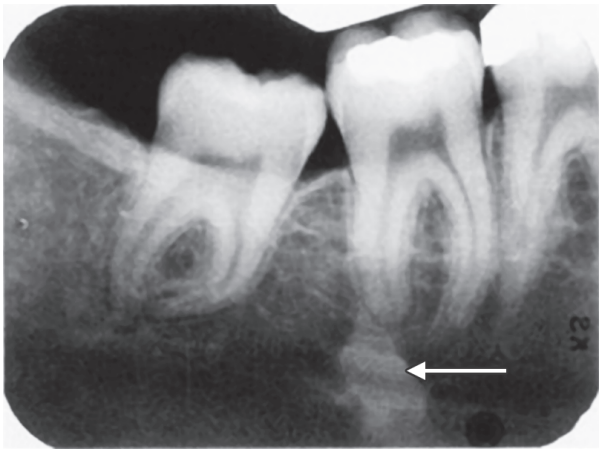

Fig. 7.21: Osteosclerosis (Dense Bony Island) DBI

adjacent bone (blending border). It surrounds the radiolucent area of rarefying osteitis around the root apex. D/D: Periapical osseous dysplasia (PCD): Common in lower anterior teeth, teeth are vital, lamina dura intact, roots not resorbed.

Differential diagnosis: Osteosclerosis (enostosis, dense bony island) (Fig. 7.21). It is seen in the bone as a ground glass like opacity in the vicinity of the tooth which is asymptomatic and disease-free, whereas condensing osteitis is seen at the periapex of a nonvital or an infected tooth. Periphery of DBI, (unlike condensing osteitis), is well defined and does not gradually merge with adjacent bone.

Periapical Osseous (Cemental) Dysplasia (POD)/PCD

It is interesting to note that HM Worth in his textbook had called this entity as periapical osteofibrosis. For many years it was named PCD and now, it is again found to be osseous tissue and not cemental and hence referred to as osseous dysplasia!

This condition is frequently seen in the mandibular anterior region and is more common in females than males (9 : 1) of the age group of 35–40 years.

It is frequently seen in Asians and three times more common in Blacks than Whites.

Multiple teeth are involved at a time and all the teeth are vital.

Stages in PCD

1. ***Stage of initiation:*** The periapical bone is converted into fibrous tissue and as a result, periapical radiolucency appears which can be confused with a periapical granuloma. But unlike in a granuloma, the tooth is vital and lamina dura may be intact.
2. ***Intermediate stage:*** Deposition of bone/cementum takes place within the radiolucent zone so that the lesion appears radiolucent with radiopaque center or as multiple areas of radiopacities (Fig. 7.22).
3. ***Maturation stage:*** During this stage, the entire fibrous tissue is converted into bone or cementum giving rise to a uniform radiopacity without any clear cut trabeculae. As the bone is completely resorbed initially and then new bone is formed, original trabculae are not seen within this lesion. In condensing osteitis, new bone is deposited in the marrow spaces around the preexisting trabeculae thereby making these trabeculae visible under magnification. In POD the radiopacity is surrounded by radiolucent halo (Table 7.2).

Fig. 7.22: Radiograph showing periapical osseous dysplasia in a mixed stage

Treatment: As it is asymptomatic and teeth in question are vital the treatment suggested is watchful inactivity! Sometimes the teeth are extracted and the osseous mass protrudes out of the mucosa after many years. At such times removal

TABLE 7.2: Differential diagnosis between condensing osteitis and PCD

Condensing osteitis	*PA cemental dysplasia*
Associated with a nonvital/infected tooth	Associated with a vital tooth
Trabeculae can be visualized within the radiopacity	Trabeculae are not seen within the radiopacity
Radiopacity surrounds a radiolucency and merges with the adjacent bone	Radiopacity is surrounded by a radiolucent halo

of these osseous structures is essential to control the pain felt by the patient.

Apical scar: Appears as a radiolucent lesion at the apex of a tooth which has undergone successful endodontic treatment and is asymptomatic. Believed to have fibrous connective tissue (with no osteogenic capacity) without any infective focus.

Postsurgical healing lesion: Seen in the periapical region of the teeth which have undergone surgical curettage/apicectomy after endodontic treatment. The healing of such lesions, starts from the periphery towards the center and hence, it shows a small central radiolucency, surrounded by peripheral radiating striae resembling a Donut or Spokes of wheel (Fig. 7.23).

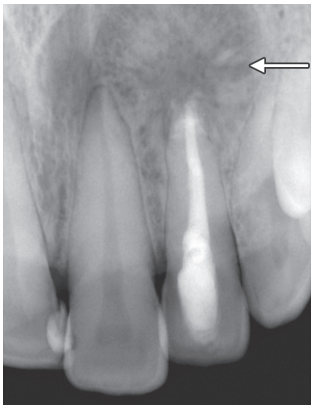

Fig. 7.23: Donut appearance of post-surgical healing lesion

References and Suggested Reading

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